ATTACHMENT B RFP 14-051

City of Naples Natural Resources Division
Trawling Efforts in Naples Bay

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I. INTRODUCTION

Naples Bay is a relatively narrow, shallow estuary ranging in width from 100 to 1500 feet, and in depth from 1 to 23 feet. The Bay's watershed once drained about 10 square miles, but it now extends to approximately 120 square miles as a result of the construction of the Golden Gate Canal system and its connection to the bay. On average, 200 million gallons of freshwater per day enter Naples Bay from the canal and disrupt the delicate balance of salt and freshwater that estuarine flora and fauna depend upon to flourish. Further, this estuary is considered impaired by the State of Florida due to excessive nutrients, bacteria, and heavy metals -- a product of excessive stormwater runoff from the urban landscape.

Until recently, the only in-depth study of Naples Bay was a 1979 effort by The Conservancy of Southwest Florida that pointed out how the bay was being polluted by all of the aforementioned factors. Yet, for years, nothing was done to address this growing problem. People knew the bay was polluted, but they did not know to what degree and for what parameters. A 2005 study produced for the City of Naples by The Conservancy of Southwest Florida found that Naples Bay has lost 90% of its seagrass beds, 80% of its oyster reefs, and 70% of its mangrove fringe since 1950. However, efforts are under way by the City to improve the water quality of the bay and increase the quality and quantity of seagrass, oysters, and mangroves living within it and along its shorelines. Over the last few years, the City's Natural Resources Division has taken many steps to improve the waters and habitat of the Naples Bay estuary, including creating artificial oyster reefs, planting mangroves along the shoreline, and protecting seagrass beds.

Over six years ago, the Natural Resources Division initiated a water quality sampling program in the bay and can now ascertain both the substances and levels of pollutants. The City has taken several steps to combat these pollutants and restore habitat. The City continues to press the South Florida Water Management District's local arm, the Big Cypress Basin, to divert water now entering Naples Bay through the Golden Gate Canal from the Bay's watershed into the Henderson Creek watershed. Henderson Creek is too saline and is starved for freshwater. Thus a diversion of this freshwater will help both systems.

Staff have concentrated on the construction of artificial oyster reefs by supplying the hard substrate necessary for free-floating oyster spat to attach to and grow into adult oysters. This not only replenishes the lost oyster reefs, but also increases habitat for the many organisms that live in and around such reefs. Further, oysters are filter feeders and remove pollutants from the water. One oyster can filter 50 gallons of water a day. A square yard of oyster reef can contain 1,000 oysters, so that means the potential of 50,000 gallons of water a day being cleaned by every square yard of oyster reef.

Staff are educating residents on the benefits of riprap as compared to seawalls in that riprap can provide for mangrove recruitment, offer nooks and crannies for estuarine organisms to live, and deflect the energy in the waves created by boat wakes. Staff have also planted mangroves and encouraged natural recruitment on riprap.

Stormwater runoff is being cleaned by floating islands and a constructed filter marsh. Staff are encouraging residents to build rain gardens to clean and retain stormwater runoff before it even enters into the stormwater system, thus reducing pollutants carried into natural water bodies.

However, the ultimate question is whether or not the bay is getting better. Water quality measurements can indicate whether or not the water is getting cleaner, but the ultimate measure is whether or not the bay has a healthy ecosystem, and that is determined by what is living in it. For that reason, staff embarked on a trawling program three years ago. It is the best way of measuring what is living in the bay and in what abundance. Comparisons can be made between the species richness of Naples Bay and more natural estuarine ecosystems in Southwest Florida that have also been trawled for years. To accomplish this, staff have partnered with Rookery Bay National Estuarine Research Reserve in an effort to sample fish species and other organisms actually living in the bay in terms of both species diversity and numbers. Every other month since 2009, staff have trawled the waters at several locations starting near Gordon Pass and moving north into the Gordon River. This sampling has already revealed that species diversity and numbers decrease to the north--furthest from the open Gulf.

II. TRAWLING AND SEINING

Trawling and seining can provide scientific, quantitative measurements as to the success of Naples Bay restoration efforts. These sampling methodologies are a means of determining the bay's inhabitants. They reveal what species are living there and in what numbers, which is a direct reflection of the health of the bay. If, over time, trawling and seining indicate that species diversity and numbers have increased, the actions taken to improve the bay will be validated.

After acquiring three years of trawling data for Naples Bay, the Natural Resources Division had a preliminary statistical analysis made of the species diversity and abundance in the Bay. The data were compared to information collected by Rookery Bay staff at several areas to the south of Naples. In general, moving south along the coast towards the Ten Thousand Islands, the effects of development on coastal waterbodies decline. So, this analysis can establish the health of Naples Bay in comparison to more natural systems to the south and enable the establishment of targets and goals for restoration efforts.

Sampling with an otter trawl net in Naples Bay.

Seining the seagrass bed.

M**easuring the catch.**

Some of the species caught.

<u>Data Collection</u>

Four fixed trawl stations were chosen throughout the length of Naples Bay based on depth characteristics and latitudinal location within the bay. At each station, a large net, termed an otter trawl, is deployed behind the boat for a set amount of time and distance (pictured above). Boards weight the net down to the bottom of the bay. Numerous fish species and other organisms living along or just above the bottom of the bay are captured. When the net is pulled in, all fish are identified, measured (standard length for first 20 animals of each species), counted and released.

Two seine stations, one at the seagrass area by Bayview Park and one at the Cowpens opposite the southern end of Port Royal, were established in relative geographic proximity, but with substrate and structural differences. For seining, a large net is pulled by hand in the shallows

(pictured above) for a set amount of time and distance, with the catch being processed the same as described for trawls.

For all sites, by-catch was estimated and categorized and water quality measurements were taken near the bottom including temperature (^{0} C), salinity (ppt), and dissolved oxygen (% saturation and mg/l). Select invertebrates, including stone crab (*Menippe mercenaria*), blue crab (*Calinectes sapidus*) and pink shrimp (*Farfantepenaeus duararum*), were measured, counted and included in the data analysis, while other notable invertebrates (squid, sea hares, swimming crabs, echinoderms) were noted and estimated, but not analyzed.

Data Analysis

Data analysis included using statistical packages useful for ecological analysis with multiple species. Naples Bay trawl data were compared to Rookery Bay, Fakahatchee Bay, Faka Union Bay and Pumpkin Bay during the same months and years. Sample sizes were the same (four per sample date). Species composition between site locations within Naples Bay, and species diversity measures and indices were calculated for each trawl site.

III. RESULTS AND DISCUSSION

There are many differences between and within estuarine areas, including geographical location, proximity to urbanization and the influence of canal and water control structures on the quantity, quality and timing of freshwater flow reaching each bay system. Other factors affecting fish recruitment to an area include spawning sites, egg and larval transport, vegetation habitat, predation pressures and competition for resources. All these factors can impact species diversity and abundance, but hydrological alterations will compound the natural stressors on populations.

Trawl Stations

A. Comparisons between bays in southwest Florida

Naples Bay, when statistically compared to all other southwest Florida estuarine bays sampled, had a statistical similarity value closer to the Ten Thousand Island (TTI) bays than to Rookery Bay. However, there were no *statistically significant* differences between bays, and additional samples may increase the chance of results with statistical significance between bay systems.

B. Comparison of sample sites within Naples Bay

Within Naples Bay, the Gordon River site was least similar to other sites, and while all other sites were similar, there were no statistically significant differences between sites in Naples Bay, which is likely attributable to the still relatively low sampling level.

C. Species Diversity within Naples Bay

Even though no significant differences were found between sites, species diversity tended to be lower at the Gordon River site. The Gordon River site is the first area to be affected by canal flow from the Golden Gate Canal system and least affected by the open waters of the Gulf of Mexico. It experiences the greatest change in salinity in the shortest amount of time. With larger fluctuations in salinity, marine species may not recruit to this area or mortality rates may be higher.

D. Individual Species within Naples Bay

Analyzing data at the species level can show effects of disturbance or pressure on an ecosystem. Significant differences can be found when individual species are isolated and tested using various statistical tests. Significant differences occur when sample size is sufficiently large and variation is small. The sample sizes analyzed here are small and variation tends to be large. Over time, when sample sizes are increased and variation becomes smaller, more individual species may show significant differences between sites.

Despite the small sample size, a few species showed significant differences between sites. The lizardfish (*Synodus foetens*), a very abundant species in trawl catches, showed significantly fewer numbers at the Gordon River site. This species' catch numbers were similar in wet and dry seasons, so site location and water quality patterns within Naples Bay may be the dominant factor influencing lizardfish abundance. Abundance of four fish species showed significant differences between sites. The fringed flounder (*Etropus crossotus*) and polka-dot batfish (*Ogcocephalus cubifrons*) showed significant differences because two stations -- City Dock and Gordon River-- had none of these species present.. The pigfish (*Orthopristis chrysoptera*) and lizardfish (*Synodus foetens*) did show significance in mean abundance between the City Dock site and the Gordon River site, with the City Dock site having greater numbers.

Seine Stations

Seining provided an excellent comparison between shallow vegetated and non-vegetated habitat in close proximity to the Gulf of Mexico. Seagrass habitat provides structure for many juvenile fish species, and species richness was significantly higher at the seagrass site. Although there was not enough data to show statistically significant differences, many individual species such as pinfish (*Lagadon rhomboids*), pigfish (*Orthopristis chrysoptera*), lane snapper (*Lutjanus synagris*), lizardfish (*Synodus foetens*), juvenile mullet (*Mugil spp*), tonguefish (*Symphurus plagiusa*) and code gobies (*Gobiosoma robustum*) all showed higher abundances in the seagrass habitat.

A few drums (*Sciaenidae*), herrings/sardines (*Clupeidae*), silversides (*Atherinidae*), halfbeaks (*Exocoetadae*) and needlefish (*Belonidae*) were more abundant (not significant) at the non-vegetated seine site at the Cowpens. The drums (spot (*Leiostomus xanthurus*) and whiting (*Menticirrus spp*)), at post-larval stages have not developed much pigment and blend in well with the white, sandy soil. The schooling herring, sardine and silversides typically occur either in large numbers or not at all. Data from these species is usually quite variable and very inconsistent. The halfbeaks and needlefish are predatory and might be present if their prey is available.

This preliminary data details the importance of bottom vegetation as structural habitat for many species of juvenile fish. Protecting current seagrass beds and restoring potential seagrass habitat would enhance recruitment areas for juvenile stages of estuarine fish species.

Bycatch

General bycatch categories consisted of mixed algae (*Laurencia spp, Caulerpa spp, Gracilaria spp*, others), sponges, tunicates, leaf litter, seagrasses (*Halophila spp, Halodule wrightii*), mangrove propagules, tree branches, jellyfish, sea hares and oysters. The City Dock site had a mean estimated bycatch (all categories grouped together) of 45.8 liters while the other trawl stations averaged 12.0, 11.0 and 13.7 liters at Doubloon Bay, Haldeman Creek and Gordon River, respectively.

Bycatch represents potential structure and food sources at a given site, which could influence the fish catch. Associations between structural bycatch and fish abundance are not well established. The floral bycatch could serve as shelter or a food source for many organisms throughout the food web. Taxonomic investigations of bycatch species is currently in progress, as well as more precise measurement techniques. This hopefully will elucidate any linkages between bycatch and fish abundance in the future.

V. RECOMMENDATIONS

Beginning in 2012, we eliminated the two seine sites from the sampling protocol and focused on otter trawls. While seining provides additional species to the overall species list that are not subject to capture in the otter trawl gear, they are not comparable to the trawl stations in Naples Bay or any other bay system monitored in this area. Further, the time and effort involved in collecting seine data is excessive when compared to the data obtained from the work. The most dominant catches are schooling fishes that are extremely variable in abundance and location at any given time. Seine sites were located at the southern end of Naples Bay and do not reflect the impacts of freshwater inflow as well as northern areas of the bay. However, we did gain valuable information regarding species in seagrass vs. non-vegetated areas.

Trawl station data from Naples Bay has been collected for just over two years, every other month. This preliminary analysis of data shows trends, but sampling events are not yet sufficient to show any *statistically significant* differences between sites within Naples Bay. Significant differences can be observed when sample size is sufficiently large and variation is small. The sample sizes analyzed here are small and variation tends to be large. Trawl data collected at fixed stations in Naples Bay was compared to other bay systems (random station selection) currently monitored in southwest Florida estuaries because the sampling efforts were the same. We recommend continuing trawl station sampling in Naples Bay to increase the probability of seeing significant differences in the data. In anticipation of continuing this project for the next several years, we have intiated a random site selection protocol that is consistent with sampling methods in the Rookery Bay system. We continue to have a total of four sites, and if alterations are made to upstream freshwater flow (diversions of Golden Gate Canal water), the trawl data will serve as a good baseline of pre-restoration conditions.

Another key component of monitoring aquatic systems is physical water quality parameters. Continuous monitoring of salinity patterns can help determine temporal changes due to freshwater entering a system. Many estuarine organisms are tolerant of change, but they all have limits to the timing and amplitude of those changes. Knowing the patterns of change in salinity (daily and seasonally) would be helpful in relating relative abundance of estuarine species to those changes. Current sampling by the Natural Resources Division and modeling of the Bay by the South Florida Water Management District are key to providing this information.

A direct comparison with the 1979 Naples Bay Study performed by The Conservancy of Southwest Florida was not possible as their mid-water trawls were sampling the upper water column and the otter trawl samples the bottom and lower water column. However, a thorough investigation of their methods, results and conclusions may reveal additional insight into Naples Bay and its tributaries.

Data presented here is a preliminary look at a complex system. Further analysis with an expanded dataset (increased samples over time) will likely produce a more detailed description of current conditions in Naples Bay. Long-term datasets are vital to determining the importance of change and restoration efforts, and this trawling project provides key data regarding the health of the bay and the quality of the habitat it provides.

VI. APPENDIX

A. 32 Species Found in Both Naples Bay and Moorings Bay

Lined sole	Southern kingfish
Bay anchovy	Polka dot batfish
Oscellated flounder	Gulf toadfish
Sheepshead	Gulf flounder
Hardhead catfish	Pink shrimp
Silver perch	Leopard sea robin
Blue crab	Bighead sea robin
Hybrid crab	Ragged Sea Hares
Sand sea trout	Southern puffer
Fringed flounder	Spider Crabs
Mojarra species	Swimming Crabs
Lined seahorse	Blackcheek tonguefish
Pinfish	Chain pipefish
Spot	Inshore lizardfish
Leptocephalus larvae	Southern hake
Lane Snapper	Fringed sea hare

B. 26 Species Found Only in Naples Bay

Feather blenny	Bonefish
Silverside	Striped anchovy
Kingfish	Mottled sea hare
Green goby	Calico crab
Planehead filefish	Striped burrfish
Atlantic thread herring	Atlantic bumper
Pigfish	Herring
Red drum	Crown conch
Shrimp spp.	Silver jenny
Mangrove snapper	Spotfin mojarra
Mantis Shrimp	Code goby
Rough silverside	Scaled sardine
Stone crab	Atlantic silverstripe halfbeak

C. 5 Species Found Only in Moorings Bay

Gaftopsail catfish
Parchment worm
Pistol shrimp
Atlantic cutlassfish
Sand perch

D. Some of the species caught in Naples Bay seining and trawling.